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**Obrejanu**

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(54) **DOWNHOLE FORCE GENERATOR**

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( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 211 days.

This patent is subject to a terminal disclaimer.

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(58) **Field of Classification Search** ................ 166/66.7, 166/98, 301, 381

See application file for complete search history.

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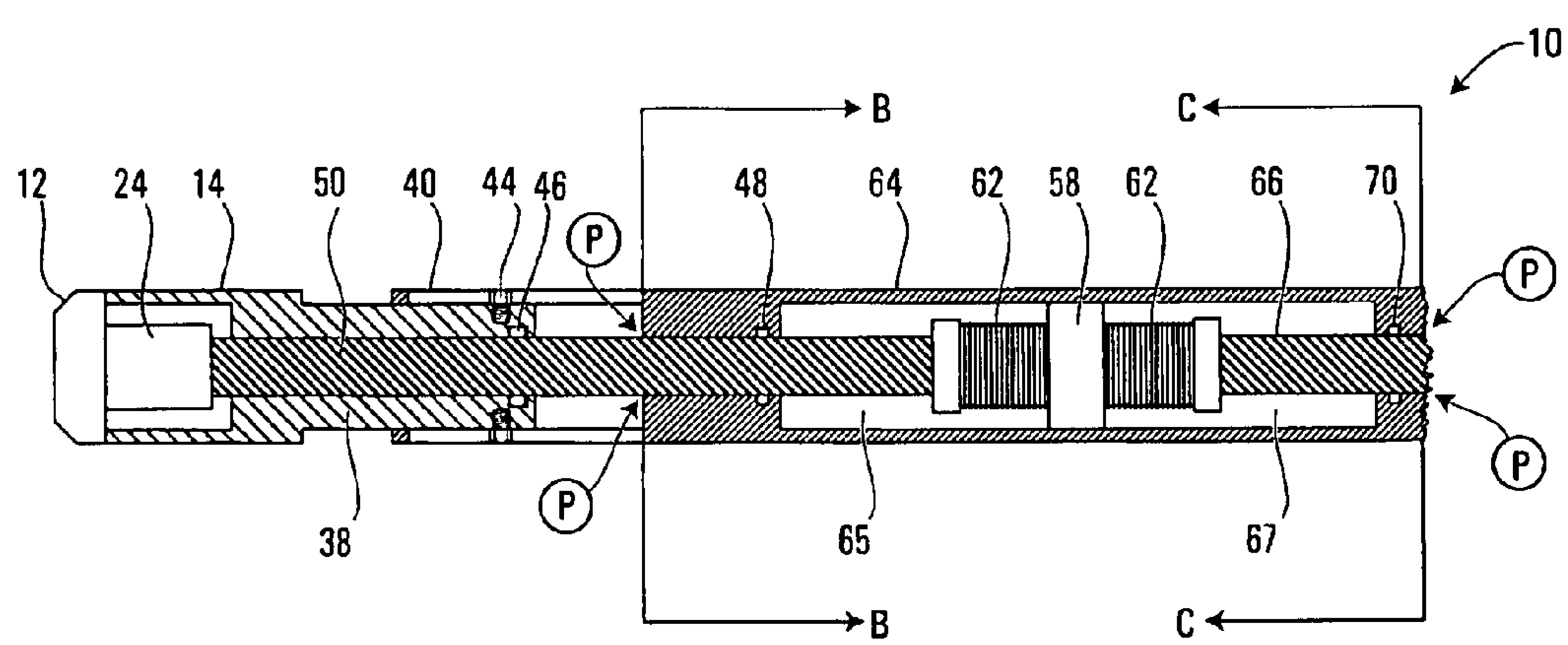
(57) **ABSTRACT**

A well tool for applying a pulling or a pushing force to an object in an interior of a well bore comprising: a) an inner member comprising a first elongated member, a second elongated member and an actuation means axially interconnecting the first elongated member and the second elongated member; b) an outer elongated member longitudinally moveably engaged with the inner member; c) a first seal defined between the first elongated member and the outer elongated member; d) a second seal defined between the second elongated member and the outer elongated member; e) a first piston area defined at a first end portion of the outer elongated member between an outer diameter of the outer elongated member and a sealed outer diameter of the first elongated member; f) a second piston area defined at a second end portion of the outer elongated member between the outer diameter of the outer elongated member and a sealed outer diameter of the second elongated member; and g) a sealed chamber defined between the first seal and the second seal, the sealed chamber including a fluid at a fluid pressure; wherein operation of the actuation means axially reversibly moves the outer elongated member relative the inner member while the fluid pressure remains constant; and wherein the first piston area and the second piston area are substantially equal and external pressure acting on these two piston areas, generates two opposing forces substantially balanced during relative movement.

**11 Claims, 7 Drawing Sheets**



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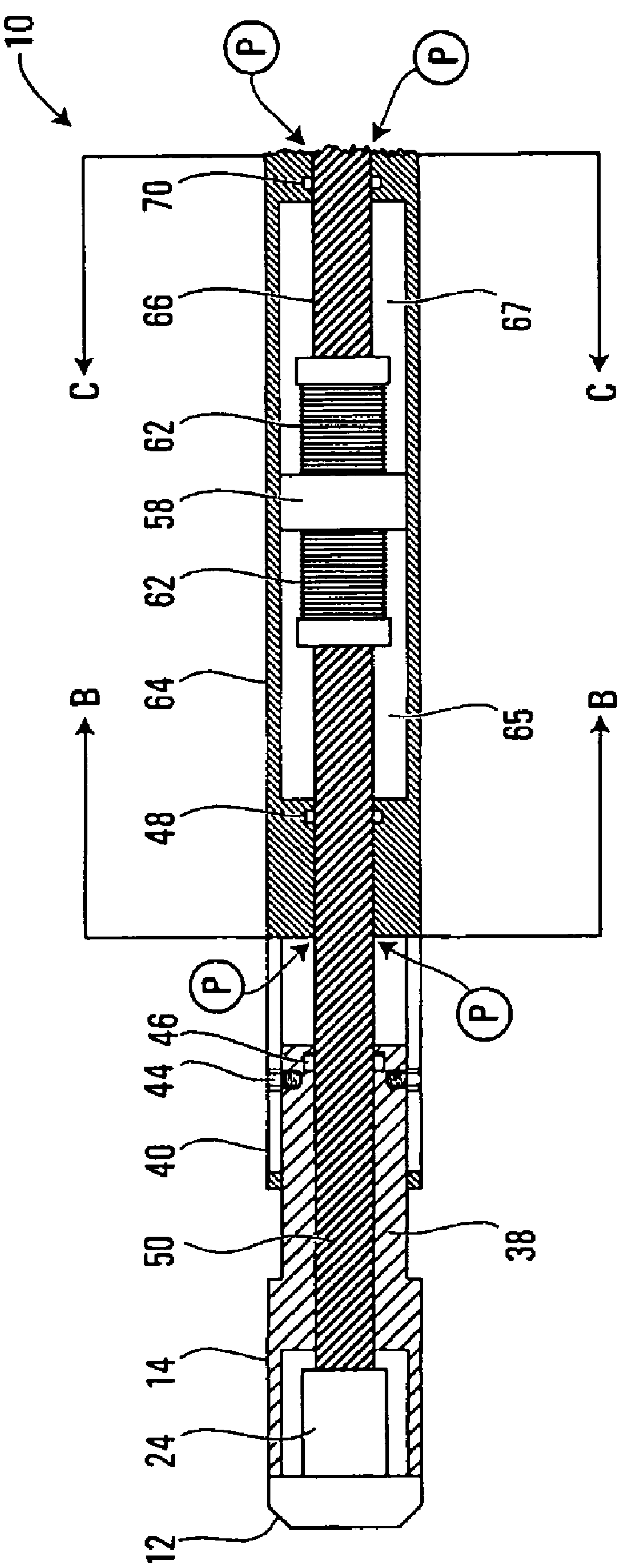


FIG. 1A

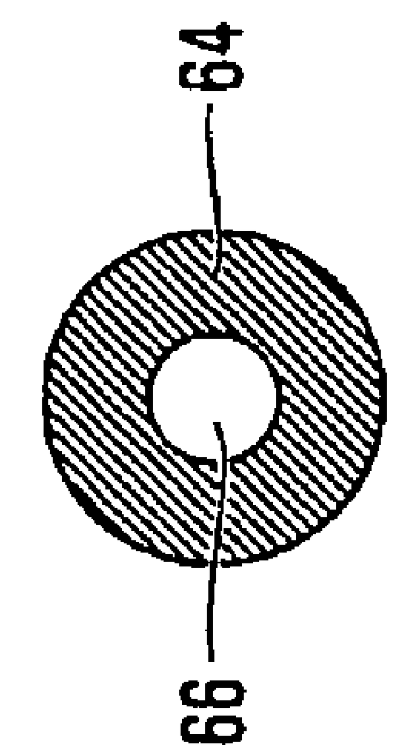


FIG. 1C

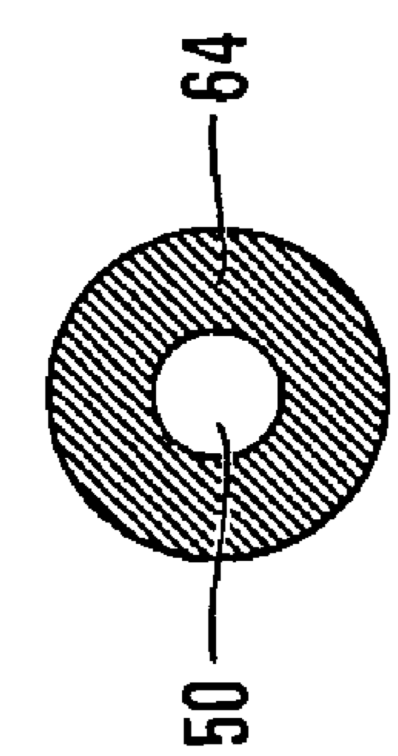


FIG. 1B

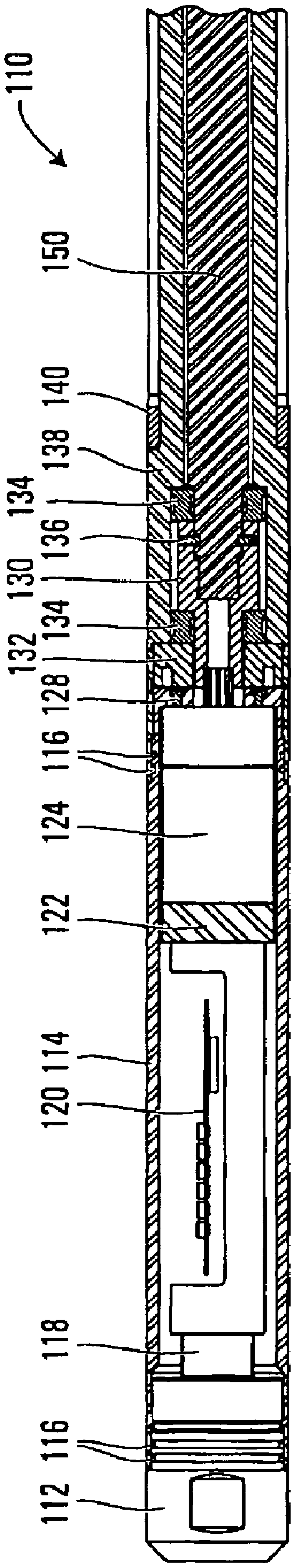


FIG. 2A

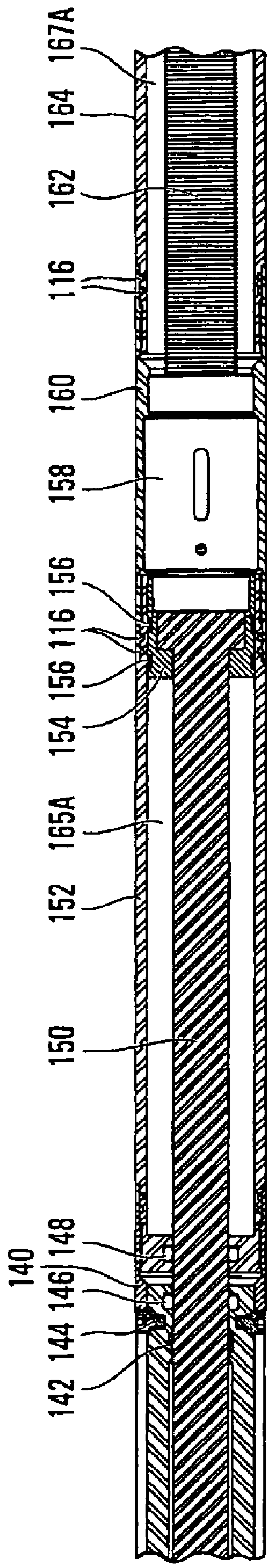


FIG. 2B

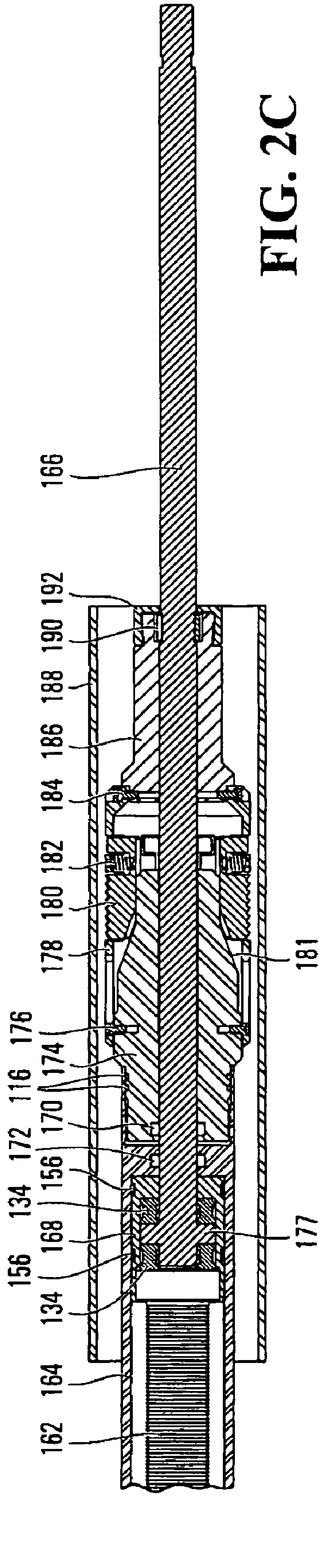


FIG. 2C

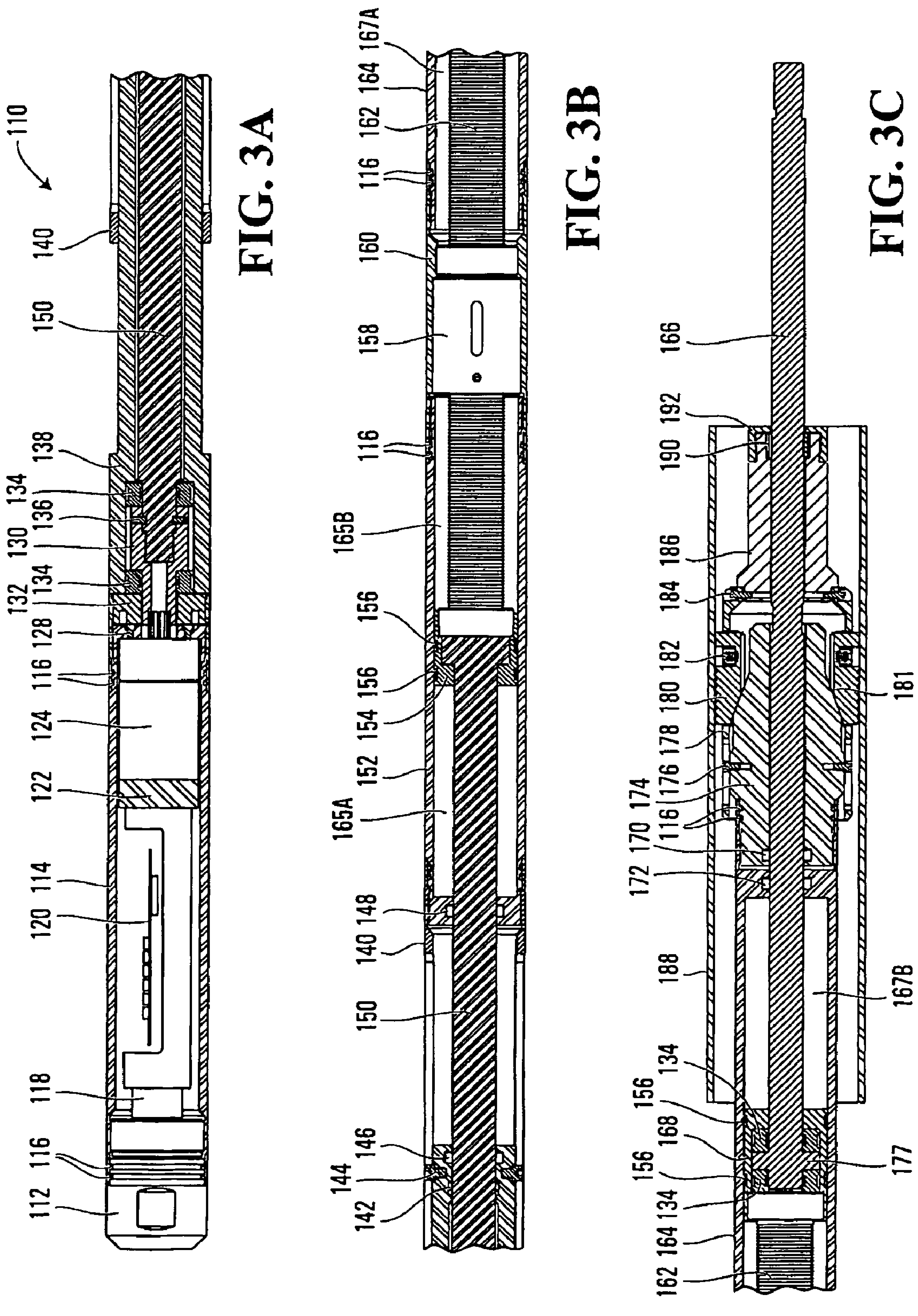


FIG. 3A

FIG. 3B

FIG. 3C

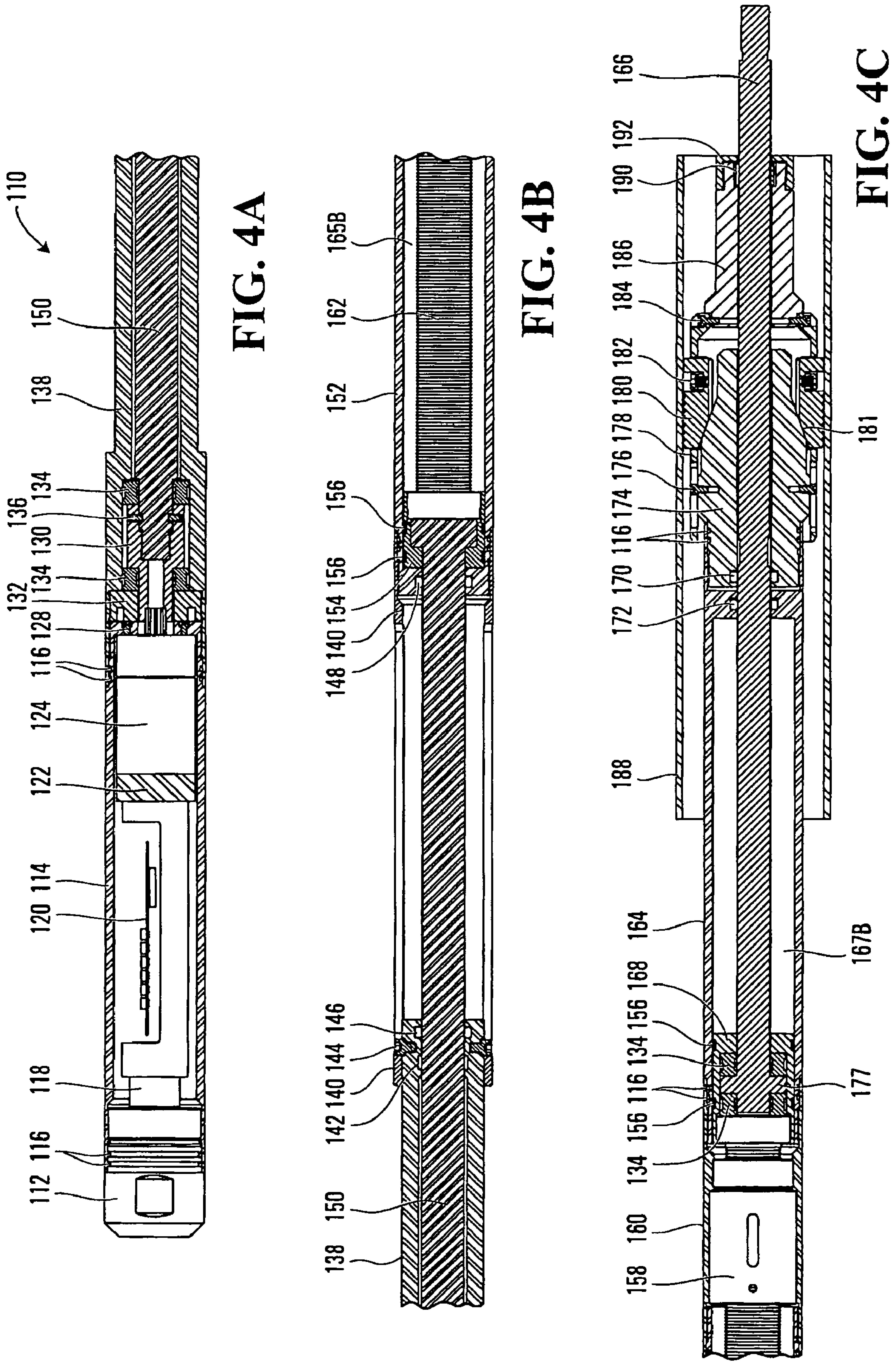


FIG. 4A

FIG. 4B

FIG. 4C

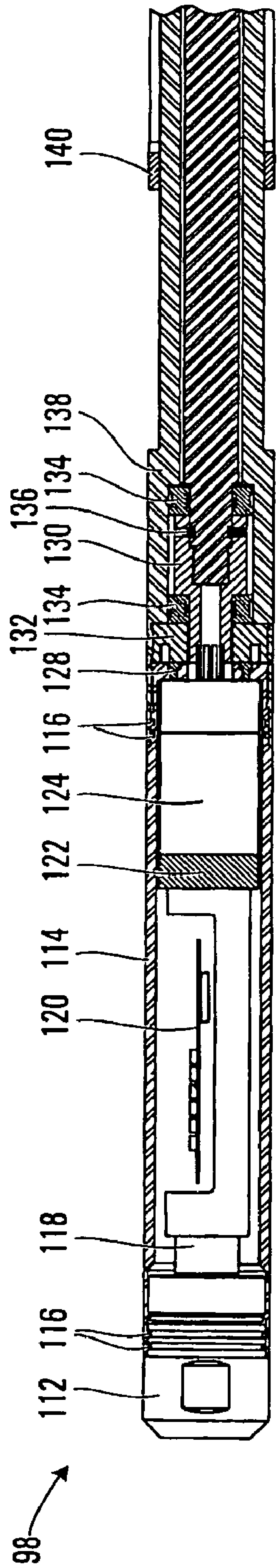


FIG. 5A

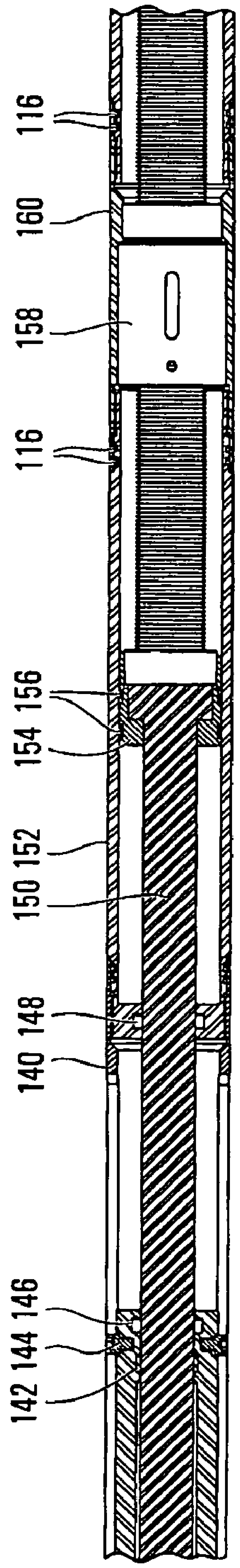


FIG. 5B

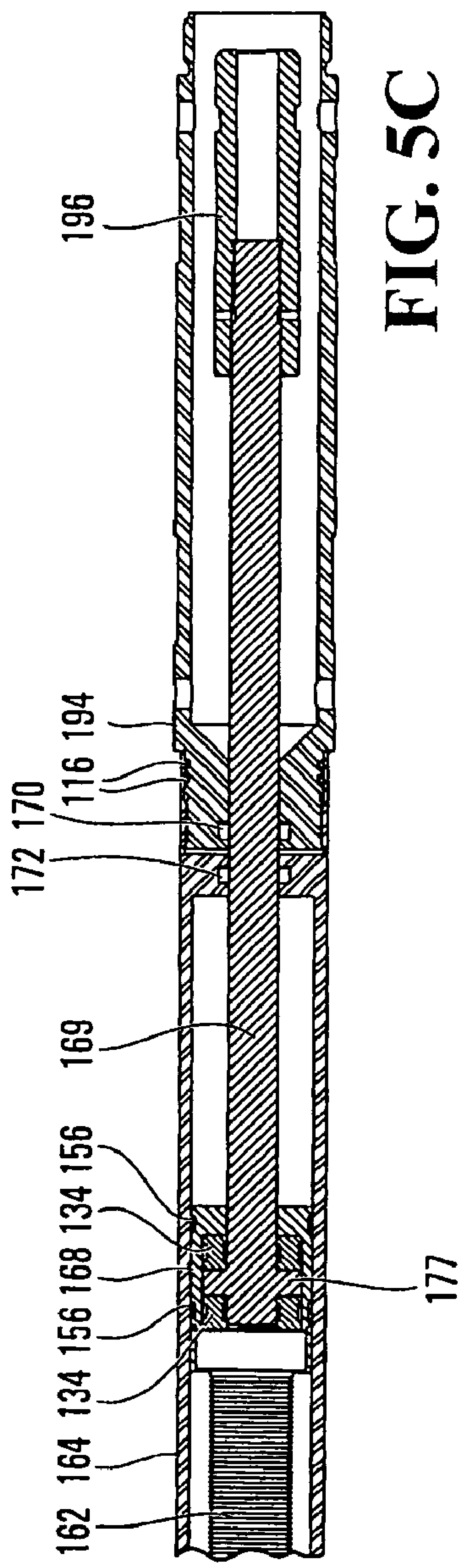


FIG. 5C

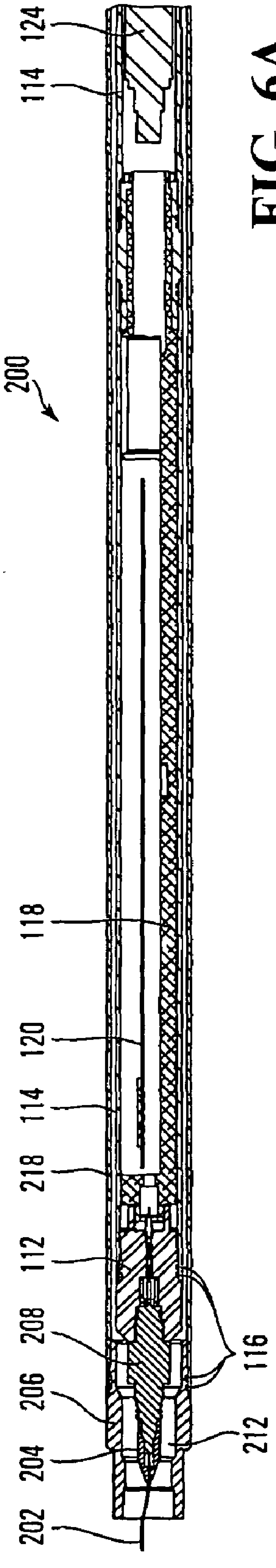


FIG. 6A

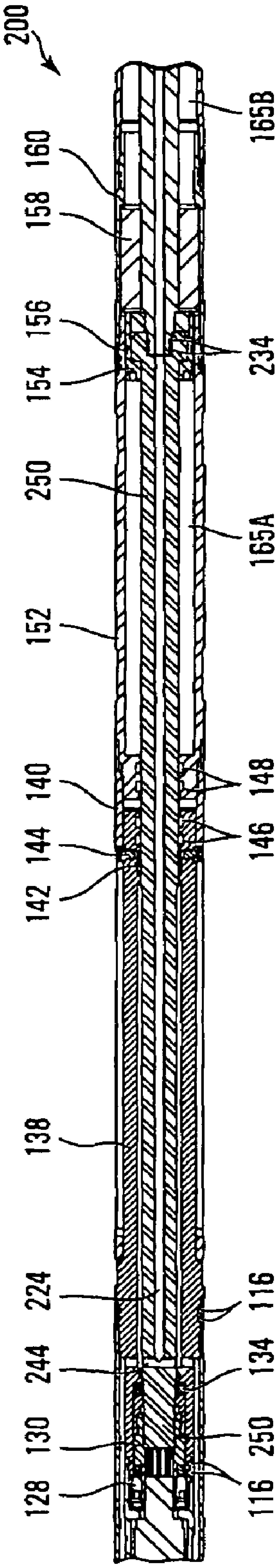


FIG. 6B

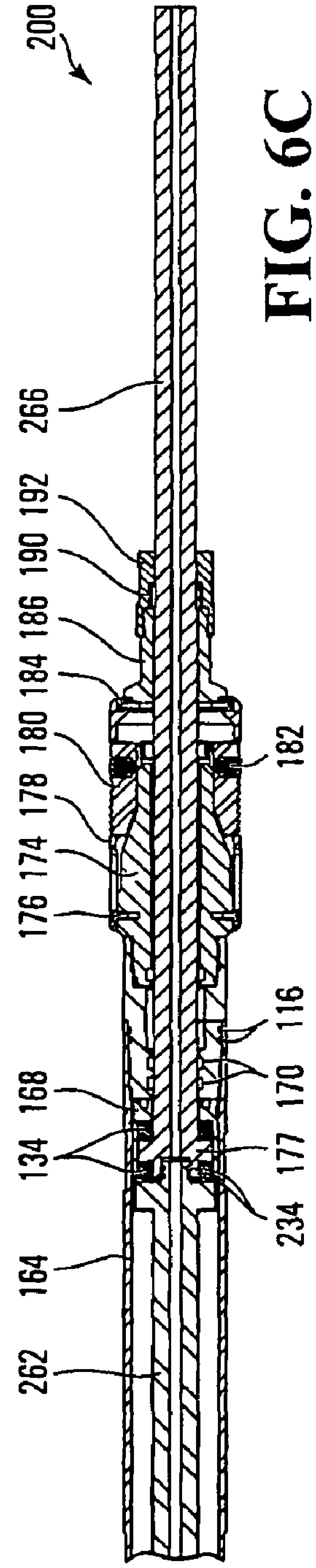


FIG. 6C

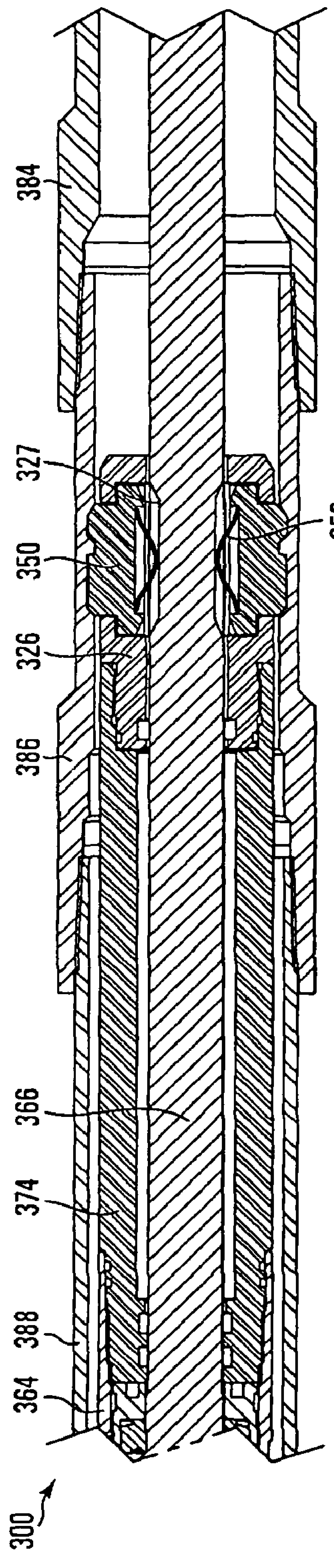


FIG. 7A

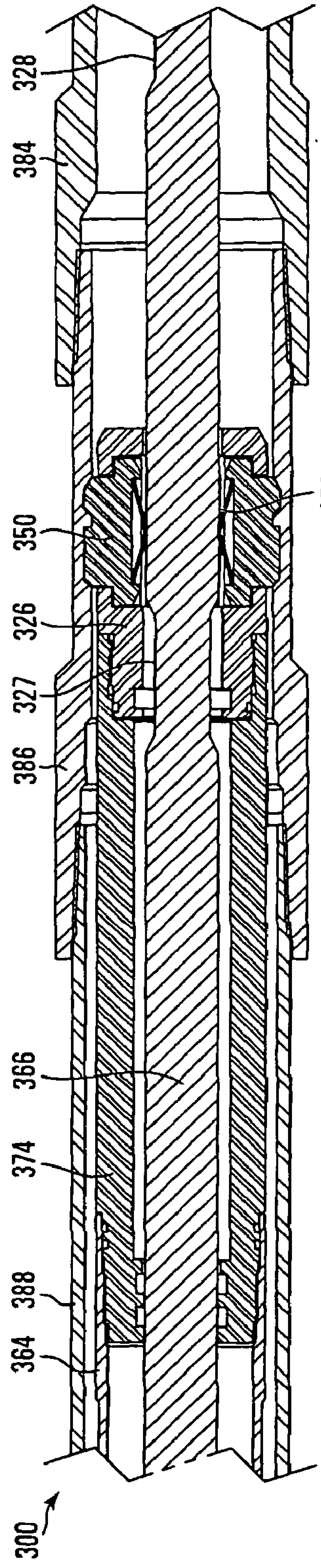


FIG. 7B

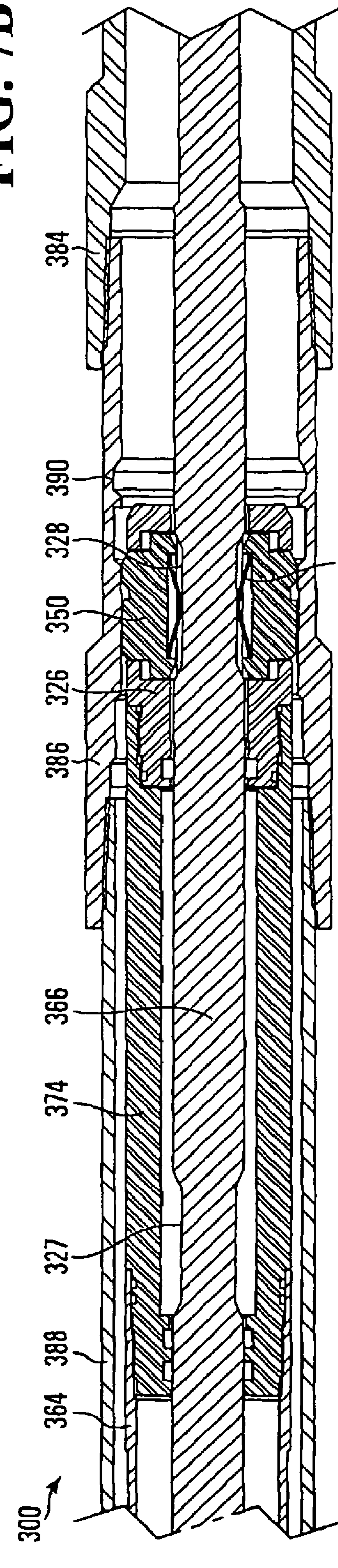


FIG. 7C

# DOWNHOLE FORCE GENERATOR

## PRIORITY CLAIM

This is a U.S. national stage of application No. PCT/CA2006/001114, filed on 7 Jul. 2006. Priority is claimed on the following application: Country: US, application Ser. No.: 11/181,592, Filed: 14 Jul. 2005; the content of which is incorporated here by reference.

## FIELD OF THE INVENTION

This invention relates to equipment for generating a force in a wellbore and more particularly but not limited to setting and retrieving tools for use in oil and gas wells.

## BACKGROUND OF THE INVENTION

The structure of a wellbore of an oil or gas well generally consists of an outer production casing and an inner production tubing installed inside the production casing. The production tubing extends from the surface to the required depth in the wellbore for production of the oil or gas. Various tools such as plugs, chokes, safety valves, check valves, etc. can be placed in landing nipples in the production tubing to allow for different production operations or the downhole control of fluid flow. Also, tools like bridge plugs, packers and flow control equipment are placed in the production casing to control production or stimulation operations. Force generating tools are needed both to exert a pushing force to set tools in the production tubing or casing and to provide a pulling force to retrieve these tools. It is preferable to have the force generating tools wellbore pressure balanced so that the same force may be applied both in pulling and in pushing operations, irrespective of the pressure in the wellbore.

A downhole force generator is disclosed in U.S. Pat. No. 6,199,628. A downhole force generator is disclosed in U.S. Pat. No. 5,070,941. A locator and setting tool is disclosed in Canadian Patent No. 2,170,711. These 3 patents describe virtually the same technology, in different variations. None of these prior art tools are pressure balanced to provide equal force in pulling and pushing operations. As detailed in the article published by Halliburton Energy Services in the June 1996 edition of the SPE Drilling & Completion magazine, "Any pressure differential increases the available force with the DPU in tension and decreases the setting force in the extension mode. This is because (1) the DPU is sealed to the well pressure through redundant sealing elements maintaining internal parts at near-atmospheric pressure, and (2) the well pressure acts on the power rod's sealed diameter." This is a disadvantage, especially in high-pressure wells. A high enough downhole pressure will render these tools unusable. Additionally, none of these tools provide a simple mechanical tool, particularly for the retrieving of downhole tools.

## SUMMARY OF THE INVENTION

According to one broad aspect, the invention provides a well tool for applying a pulling or a pushing force to an object in an interior of a well bore comprising: a) a drive mandrel; b) an engaging mandrel; c) an actuation means; d) a housing sealing a portion of the drive mandrel and a portion of the engaging mandrel within an interior space, the drive mandrel and the engaging mandrel extending from opposite ends of the housing; e) a drive mandrel piston area defined at a drive mandrel end portion of the housing between an outside diameter of the housing and a sealed diameter of the drive mandrel; and f) an engaging mandrel piston area defined at an engaging mandrel end portion of the housing between the outside diameter of the housing and a sealed diameter of the engaging mandrel; wherein the actuation means is adapted to reversibly move the housing longitudinally relative to the drive mandrel and the engaging mandrel and wherein the drive mandrel piston area and the engaging mandrel piston area are substantially equal and external pressure acting on these two piston areas, generates two opposing forces that are substantially balanced during relative movement.

According to another broad aspect, the invention provides a well tool for applying a pulling or a pushing force to an object in an interior of a well bore comprising: a) an inner elongated member; b) an outer elongated member; c) a sealed interior defined between the inner elongated member and the outer elongated member; and d) an actuation means defined at least partially within the sealed interior; wherein the actuation means is adapted to reversibly move the outer elongated member longitudinally over the inner elongated member and wherein the inner elongated member and the outer elongated member are arranged such that a volume of the sealed interior occupied by the inner elongated member remains substantially constant as the inner elongated member and the outer elongated member move relative to each other.

According to a further broad aspect, the invention provides a well tool for applying a pulling or a pushing force to an object in an interior of a well bore comprising: a) an inner elongated member; b) an outer elongated member encircling an intermediate segment of and longitudinally moveably engaged with the inner elongated member; c) a screw component of the inner elongated member, the screw component being coupled for rotation about a longitudinal axis; and d) a threaded component of the outer elongated member engaged with the screw component; wherein rotation of the screw component reversibly moves the outer elongated member relative to the inner elongated member.

According to a still further broad aspect, the invention provides a well tool for applying a pulling or a pushing force to an object in an interior of a well bore comprising: a) an inner member comprising a first elongated member, a second elongated member and an actuation means axially interconnecting the first elongated member and the second elongated member; b) an outer elongated member longitudinally moveably engaged with the inner member; c) a first seal defined between the first elongated member and the outer elongated member; d) a second seal defined between the second elongated member and the outer elongated member; e) a first piston area defined at a first end portion of the outer elongated member between an outer diameter of the outer elongated member and a sealed outer diameter of the first elongated member; f) a second piston area defined at a second end portion of the outer elongated member between the outer diameter of the outer elongated member and a sealed outer diameter of the second elongated member; and g) a sealed chamber defined between the first seal and the second seal, the sealed chamber including a fluid at a fluid pressure; wherein operation of the actuation means axially reversibly moves the outer elongated member relative the inner member while the fluid pressure remains constant; and wherein the first piston area and the second piston area are substantially equal and external pressure acting on these two pistons areas, generates two opposing forces that are substantially balanced during relative movement.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will now be described with reference to the attached drawings in which:

FIGS. **1**A, **1**B and **1**C are partial schematic cross-sectional views of a first embodiment of the invention;

FIGS. **2**A, **2**B and **2**C are detailed upper, middle and lower cross-sectional views, respectively, of the first embodiment of the invention in a first position;

FIGS. **3**A, **3**B and **3**C are detailed upper, middle and lower cross-sectional views, respectively, of the embodiment of FIGS. **2**A, **2**B and **2**C in a second position;

FIGS. **4**A, **4**B and **4**C are detailed upper, middle and lower cross-sectional views, respectively, of the embodiment of FIGS. **2**A, **2**B and **2**C in a third position;

FIGS. **5**A, **5**B and **5**C are detailed upper, middle and lower cross-sectional views, respectively, of a second embodiment of the invention;

FIGS. **6**A, **6**B and **6**C are detailed upper, middle and lower cross-sectional views, respectively, of a third embodiment of the invention; and

FIGS. **7**A, **7**B and **7**C are partial cross-sectional views of a forth embodiment of the invention in first, second and third positions, respectively.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1**A shows cross-sectional view of a simplified embodiment of the invention. A tool **10** has an inner elongated member which includes a drive mandrel **50**, a screw **62** and an engaging mandrel **66**. The engaging mandrel may be a setting or a retrieving mandrel. The drive mandrel **50** and the screw **62** are axially coupled for both rotational and longitudinal movement. The engaging mandrel **66** and the screw **62** are preferably coupled for longitudinal movement only. The cross-sectional area of the drive mandrel **50** is substantially equal to the cross-sectional area of the engaging mandrel **66**.

The tool **10** also includes an outer elongated member or main housing **64**. The outside diameter of the main housing **64** is preferably constant. Fixed to the interior of the main housing **64** is a threaded component or nut **58**. The nut **58** is threaded on the screw **62**. One end of the main housing **64** is sealed to the drive mandrel **50** by a seal **48**. The other end of the main housing **64** is sealed to the engaging mandrel **66** by a seal **70**. The sealed interior of the main housing **64** is preferably equalized with the wellbore pressure. The connection between the screw **62** and the nut **58** is not fluid tight, i.e. chambers **65** and **67** on either side of the nut **58** are enclosed by the main housing **64** and are in fluid communication through gaps between the screw **62** and nut **58** and/or channels milled on the outside of the nut **58**.

The drive mandrel **50** is coupled at its other end to a motor **24**. The motor **24** is contained within a motor housing **14**. A connector **12** is provided at the other end of the motor for electrically and mechanically connecting the tool **10**. Cap screws **44** are provided in a guide sleeve **38** formed at the end of the motor housing **14** which encircles the drive mandrel **50** and an electronics seal **46** is provided around the drive mandrel **50** which seals the guide sleeve to the mandrel **50** to protect the inside of the motor housing **14** from the environment. A guide housing extension **40** of the main housing **64** slidably encompasses a portion of the guide sleeve **38**. The cap screws **44** travel in slots in the guide housing extension **40** and prevent rotation of the main housing **64**.

In operation, the connector **12** is electrically and mechanically connected to a wireline. The motor **24** rotates the drive mandrel **50**. Rotation of the drive mandrel **50** causes the screw **62** to rotate. The main housing **64** is held against rotation so that rotation of the screw **62** causes the main housing **64** to move longitudinally over the inner elongated member. At all times, the volume of the drive mandrel entering/exiting the interior space is the same as the volume of the engaging mandrel exiting/entering the interior space so that the free volume, and therefore also the pressure, in the interior space remains constant. The seals **48** and **70**, define two hydraulic pistons between the outside diameter of the main housing **64** and the outside diameter of the drive mandrel **50** and the outside diameter of the engaging mandrel **66** respectively. The two piston areas, shown schematically in FIGS. **1**B and **1**C, have the same area. Any outside well pressure P acting on these two hydraulic piston areas will create two equal opposing forces that cancel each other. The constant volume in the interior and the matched piston areas enable the same force to be applied by the tool in both the pushing and the pulling operations. The main housing **64** and/or the engaging mandrel **66** are coupled to engaging tools for setting or retrieving of downhole tools.

In greater detail, FIGS. **2**A to **4**C depict a well tool, in particular a wireline retrieving tool for applying a pulling force to an object in the interior of a wellbore. The wireline retrieving tool **110** is generally tubular in shape. A connector **112** is located at the proximal end of the wireline retrieving tool **110**. The proximal end is the upper or trailing end when the wireline retrieving tool **110** is inserted into a wellbore. The connector **112** allows for mechanical and electrical connection of the wireline retrieving tool **110** to a wireline. The connector **112** connects to a proximal end of a tubular electronics housing **114**. Seals **116** are provided at the interface between the connector **112** and the electronics housing **114** to seal the interior of the electronics housing **114** from the environment. The electronics housing **114** houses an electronics carrier **118**, a printed circuit board **120**, a digital positioning encoder **122** and a gear motor **124**. The electronics carrier provides mechanical support for the printed circuit board **120**. The connector **112** is connected to the printed circuit board **120** to provide power to the printed circuit board from the wireline. The printed circuit board **120** provides control for the operation of the digital positioning encoder **122** and the gear motor **124**. The digital positioning encoder **122** is connected at one end of the gear motor **124**. The digital positioning encoder **122** counts the rotation of the gear motor **124** to allow precise calculation and control of the movement of the distal end, i.e. lower or leading end, of the wireline retrieving tool **110**.

A distal end of the electronics housing **114** is connected to a guide sleeve **138**. The guide sleeve is generally tubular. Seals **116** are provided between the guide sleeve **138** and the electronics housing **114** to seal the interior from the environment. A drive mandrel **150** extends at least partially through the guide sleeve **138**. The drive mandrel **150** is generally an elongated solid member with a circular cross-section. The drive mandrel **150** is interconnected to the gear motor **124** through a spline adapter **130**. The spline adapter **130** interconnects the gear motor **124** to the drive mandrel **150** through axial splines so that rotation of an output of the gear motor **124** results in rotation of the drive mandrel **150** at the same speed. The spline adaptor **130** is threaded to the drive mandrel **150**. Set screws **136** hold the drive mandrel **150** in position relative to the spline adaptor **130**.

Thrust bearings **134** are provided at support ends of the spline adapter **130** to facilitate smooth rotation of the drive mandrel **150** relative to the guide sleeve and the electronics housing. A drive mandrel lock nut **132** is provided to retain the bearings **134** and the spline adaptor in the guide sleeve **138** and cap screws **128** are provided to fasten the gear motor to the distal end of the electronics housing **114**.

Cap screws **144** are provided at a distal end of the guide sleeve **138**. The heads of the cap screws **144** project outward from the surface of the guide sleeve **138**. An upper guide housing **140** slidably encompasses a portion of the guide sleeve **138**. Longitudinal slots are defined in the upper guide housing **140**. The cap screws **144** travel within the longitudinal slots in the upper guide housing **140** when the upper guide housing **140** slides relative to the guide sleeve **138**. The cap screws **144** rest against the ends of the longitudinal slots to retain the upper guide housing **140** in contact with the guide sleeve **138** at the limits of relative travel and prevent relative rotation between the guide housing **138** and the upper guide housing **140**.

A glide ring **142** is also provided adjacent the cap screws **144** between the guide sleeve **138** and the drive mandrel **150** to facilitate the smooth rotation of the drive mandrel **150**. An electronics seal **146** is provided around the drive mandrel **150** at the distal end of the guide sleeve **138**. The electronics seal **146** seals the electronic section from external contaminants and keeps it at atmospheric pressure.

The distal end of the upper guide housing **140** mates with a proximal end of an upper housing **152**. The upper housing **152** is also generally tubular. The upper guide housing **140** and the upper housing **152** are retained relative to one another by a threaded connection. An upper interior area seal **148** is provided at a proximal end of the upper housing **152** and seals the upper housing **152** to the drive mandrel **150**. The upper internal area seal **148** seals the interior of the upper housing **152**. The electronics seal **146** and the upper internal area seal **148** allow for rotation of the drive mandrel **150**.

A distal end of the upper housing **152** is coupled to a proximal end of an actuator housing **160**. The actuator housing **160** is generally tubular. An actuator nut **158** is non-rotatably held within the actuator housing **160**. An actuator screw **162** extends through the actuator nut **158**. The actuator screw **162** is coupled to a distal end of the drive mandrel **150**. The coupling is provided by an anti-rotational lug so that the actuator screw **162** rotates with the drive mandrel **150**. A drive mandrel retainer **154** is provided within the upper housing **152** which maintains the drive mandrel **150** in contact with the actuator screw **162**. Glide rings **156** are provided around the circumference of the drive mandrel retainer **154** to allow smooth rotation of the drive mandrel retainer **154** within the upper housing **152**.

Upper chambers **165**A and **165**B (FIGS. **3**B and **3**C) are defined within the upper housing **152** which accommodate the drive mandrel retainer **154** when the upper housing **152** moves longitudinally relative to the drive mandrel **150**. Upper chambers **165**A and **165**B are in permanent communication.

Seals **116** are provided at the interface of the upper housing **152** and the actuator housing **160** to protect the interior of the upper chambers from the environment. A bottom housing **164** connects to the distal end of the actuator housing **160**. Seals **116** are provided between bottom housing **164** and the actuator housing **160** to protect the interior from the environment.

The actuator screw **162** extends through the bottom housing **164**. The actuator nut **158** is engaged with the actuator screw **162** such that rotation of the actuator screw **162** moves the actuator nut **158** relative to the actuator screw **162**. Other screw components and threaded components may be utilized.

The distal end of the actuator screw **162** is coupled to a retrieving mandrel **166**. The retrieving mandrel **166** is generally an elongated solid member with a circular cross-section of substantially the same diameter as the drive mandrel **150**. The actuator screw **162** is coupled to the retrieving mandrel **166** by a retrieving mandrel retainer **168**. The proximal end of the retrieving mandrel **166** adjacent to the actuator screw **162** has a shoulder **177**. On either sides of the shoulder **177** are thrust bearings **134**. The thrust bearings **134** allow longitudinal movement of the actuator screw **162** to be transmitted to the retrieving mandrel **166** but rotational movement of the actuator **162** is not transmitted to the retrieving mandrel **166** such that retrieving mandrel **166** moves longitudinally but does not rotate. Glide rings **156** are positioned between the retrieving mandrel retainer **168** and the bottom housing **164** to allow smooth longitudinal and rotational movement of the retrieving mandrel retainer **168** relative to the bottom housing **164**.

Bottom chambers **167**A and **167**B (FIGS. **3**B and **3**C) are defined within the bottom housing **164** which accommodate the retrieving mandrel retainer **168** when the bottom housing **164** moves longitudinally relative to the retrieving mandrel **166**. The bottom chambers **167**A and **167**B are in permanent communication.

A distal end of the bottom housing **164** is coupled to a setting cone **174**. Seals **116** are provided between the bottom housing **164** and the setting cone **174**. A lower internal area seal **170** is provided between the setting cone **174** and the retrieving mandrel **166**. A lower secondary interior area seal **172** is provided between the bottom housing **164** and the retrieving mandrel **166**. The lower internal seal **170** provides a primary seal to seal the interior of the bottom housing **164** from the external environment. The lower secondary interior seal **172** provides a backup seal.

A slip cage **178** holds a set of slips **180** on the setting cone **174**. Cap screws **176** connect the slip cage **178** to the setting cone **174**. The slip cage **178** is moveable relative to the setting cone **174** by movement of the cap screws **176** in slots defined in the slip cage **178**. The slips **180** are biased inward by springs **182**.

A C-ring **190** is provided which sits in a circumferential recess in the retrieving mandrel **166**. The C-ring **190** sits inside a C-ring housing **186** which is connected to the setting cone **174** by cap screws **184**. The C-ring **190** is retained within the C-ring housing **186** by a C-ring retainer **192**. A segment of the production tubing or casing **188** is shown to facilitate the explanation of the operation of the wireline retrieving tool **110**.

The drive mandrel **150** and the retrieving mandrel **166** are of substantially the same diameter so that the volume of either mandrel entering the sealed interior defined by the upper housing **152**, the actuator housing **160**, and the bottom housing **164** is substantially the same as the volume of the other mandrel exiting the sealed interior so that the free volume within the sealed interior remains substantially constant. A hydraulic piston defined between the outside diameter of the upper housing **152** and the outside diameter of the drive mandrel **150** and a hydraulic piston defined between the outside diameter of the bottom housing **164** and the outside diameter of the retrieving mandrel **166** are equal in area. Any outside well pressure acting on these two hydraulic piston areas will create two equal opposing forces that cancel each other. This provides the same power availability for pushing and pulling.

The operation of the wireline retrieving tool **110** is explained with reference to FIGS. **2**A to **2**C, **3**A to **3**C and **4**A to **4**C which show the wireline retrieving tool **110** in three different positions. The same reference characters are used in all three figures to refer to the same elements. In operation, the wireline retrieving tool **110** is connected by connector **112** to a wireline, both electrically and mechanically. The wireline retrieving tool is lowered into a segment of the production tubing or casing **188** to a desired location. At that location, the gear motor **124** is operated via the printed circuit board **120**. The digital positioning encoder **122** counts the rotations of the gear motor **124** so that an exact position of the retrieving mandrel **166** can be obtained. Rotation of the gear motor **124** is translated to the drive mandrel **150** to provide rotation of the drive mandrel **150**.

In the initial position depicted in FIGS. **2**A to **2**C, only chambers **165**A and **167**A are open. The drive mandrel **150** is coupled to the actuator screw **162** as noted above so that rotation of the drive mandrel **150** provides rotation of the actuator screw **162** at the same rate of rotation. Rotation of the actuator screw **162** moves the actuator nut **158** downward along the actuator screw **162** as seen in FIGS. **3**A to **3**C. This opens up chambers **165**B and **167**B at the same rate that chambers **165**A and **167**A are closed. The movement of the actuator nut **158** in turn moves the upper guide housing **140**, the upper housing **152**, the actuator housing **160** and the bottom housing **164** downward. The bottom housing **164** in turn pushes the setting cone **174** downward.

The C-ring housing **186** is held against downward movement by the C-ring **190** seated in the recess on the retrieving mandrel **166**. This also holds the slips **180** stationary relative to the retrieving mandrel **166**. The setting cone **174** slides relative to the slips **180**. The setting cone **174** has a narrower end initially within the slips **180** and expands along a shoulder **181** to a wider section. As the shoulder **181** is forced through the slips **180**, the slips are moved outward, the springs **182** are compressed and the slips bite into the segment of production tubing or casing **188** and hold the slips stationary relative to the production tubing or casing **188** (see FIGS. **3**A to **3**C). Further rotation of the actuator screw **162** no longer moves the housing downwardly, instead, further rotation of the actuator screw **162** will force the expansion and release the C-ring **190** from the retrieving mandrel **166** and the proximal end of the wireline retrieving tool **110** moves upwardly to the upper limit of travel shown in FIGS. **4**A to **4**C. In this final position, chambers **165**A and **167**A are completely closed and chambers **165**B and **167**B are completely open.

All of chambers **165**A, **165**B, **167**A and **167**B are in fluid communication through gaps between the actuator screw **162** and the actuator nut **158** and gaps between the coupling assemblies interconnecting the actuator screw **152** to the mandrels **150** and **166** and the housings **152** and **164**. The mandrels **150** and **166** have substantially the same cross section. As a result, the combined free volume of the chambers **165**A, **165**B, **167**A and **167**B remains substantially constant throughout the relative movement of the housings so that the pressure within the sealed interior of the tool **110** remains constant. Also, because the mandrels **150** and **166** have the same cross section, any outside well pressure acting on the two opposing hydraulic pistons defined by the outside diameters of the housings **152** and **164** and the outside diameters of the mandrels **150** and **166**, would generate two equal opposing forces that would cancel each other and would not affect the function of the tool in pushing or pulling operations.

In operation, a fishing tool is attached to the distal end of the wireline retrieving tool **110**. The further rotation of the actuator screw **162** pulls the fishing tool upward against the holding force of the slips against the segment of production tubing or casing **188**. Thus, the pulling force is not provided by the wireline but instead by the action of the retrieving mandrel **166** against the slips **180**.

To reset the tool, the actuator screw **162** is rotated in the opposite direction causing the upper guide housing **140**, the upper housing **152**, the actuator nut **158**, the actuator housing **160**, the bottom housing **164** and the setting cone **174** to move upward. The withdrawal of the shoulder **181** of the setting cone **174** from the slip **180** results in the springs **182** retracting the slips **180** from contact with the segment of production tubing or casing **188**. The wireline retrieving tool **110** can then be withdrawn from the production tubing or casing. Alternatively, if the object to be retrieved is not completely free, the wireline retrieving tool **110** can be partially withdrawn up the production tubing or casing **188** and reset to perform a second or other subsequent pulling operations in the same manner as described above.

FIGS. **5**A to **5**C depicts a wireline setting tool **198**. The same reference characters are used in FIGS. **5**A to **5**C for the same components as identified in FIGS. **2**A to **4**C. It can be seen that the only difference between the wireline retrieving tool **110** of FIGS. **2**A to **4**C and the wireline setting tool **198** of FIGS. **5**A to **5**C is the assembly at the distal end. In particular, the wireline setting tool **198** does not contain a slip assembly. Instead, a setting housing **194** is connected at the distal end of the bottom housing **164**. As with the wireline retrieving tool **110**, a lower internal area seal **170** seals against a mandrel, in this case a setting mandrel **169**, of substantially the same diameter as the upper interior seal **148** which seals against the drive mandrel **150**. A setting adapter **196** is fixed to the distal end of the setting mandrel **169**. A tool to be set is fixed to the end of the setting housing **194** and the setting adapter **196**. When the wireline setting tool **198** is actuated in the manner as described with regard to the wireline retrieving tool **110**, the housings **140**, **152**, **160**, **164** and **194** move downward over the setting mandrel **169** and the force thus exerted is used to set a tool to be placed in the production tubing or casing (not shown). In FIGS. **5**A to **5**C, the wireline setting tool **198** is shown with the actuator nut **158** in an intermediate position such that the housings are partly but not fully extended.

The tools depicted in FIGS. **1**A to **5**C are intended to be deployed by a wireline. A wireline is flexible and uses gravity to lower a tool into position. For horizontal or highly deviated wells, a wireline alone may not allow a tool to be properly positioned in the well. Instead coiled tubing with a wireline installed inside it, also known as stiff wireline, is used. Coiled tubing consists of a hollow tube that surrounds the wireline and can be used to push a tool into a horizontal well. Coiled tubing is typically relatively thin walled. As a result, to prevent the tubing from collapsing under well pressure and mechanical forces, it is necessary to allow pressurized completion fluids to flow through the coiled tubing and through the tool.

FIGS. **6**A to **6**C depict an embodiment of a retrieving tool that has been adapted for use with coiled tubing. FIGS. **6**A to **6**C use the same reference characters that are used in FIGS. **2**A to **4**C for the same components. FIGS. **6**A to **6**C will be described only in respect to how they differ from FIGS. **2**A to **4**C. FIGS. **6**A to **6**C depict a retrieving tool **200**. A flow path is defined through the retrieving tool **200** to allow fluid to flow through the coiled tubing as detailed in the following description.

At a proximal end of the retrieving tool **200** there is the connector **112** for connecting to a wireline as explained above. FIG. **6**A depicts additional components at a proximal end of the connector **112**, not shown in FIGS. **2**A to **4**C. In particular, an electrical contact sub **208** and a rubber boot **204** are shown as interconnecting between a segment of wireline **202** and the connector **112**. The electrical contact sub **208** and the rubber boot **204** do not form part of the retrieval tool **200**. They serve to mechanically and electrically interconnect the connector **112** to the wireline **202**.

The connector **112** is connected at its distal end to the electronics housing **114** as in FIGS. **2**A to **4**C. However, in FIG. **6**A, the electronics housing **114** is surrounded by a bypass sleeve **218**. A proximal end of the bypass sleeve **218** is connected to a coiled tubing connector **206**. The bypass sleeve **218** and the coiled tubing connector **206** are both hollow, and may be tubular. The coiled tubing connector **206** is adapted to connect to the coiled tubing at its free end so that the coiled tubing can be used to position the retrieving tool **200** in the well.

As can be seen in FIG. **6**A, the combination of the coiled tubing connector **206** and the bypass sleeve **218** define an outer hollow member in fluid connection with the coiled tubing. The wireline **202**, the rubber boot **204**, the electrical contact sub **208**, the connector **112**, and the electronics housing **114** define an inner member surrounded by the outer hollow member. An elongated fluid chamber or conduit **212** is defined between the inner member and the outer member which allows fluid to flow down the coiled tubing and around the electronics. The electronics remain sealed from the fluid chamber **212**.

FIGS. **6**A to **6**C also depict an inner elongated member comprised of a drive mandrel **250**, an actuator screw **262** and a retrieving mandrel **266** comparable the drive mandrel **150**, the actuator screw **162** and the retrieving mandrel **166**. The difference between the inner elongated member of FIGS. **6**A to **6**C, from the inner elongated member of FIGS. **2**A to **4**C, is that the inner elongated member of FIGS. **6**A to **6**C has a fluid flow port or conduit **224** defined longitudinally therethrough. The drive mandrel **250** the actuator screw **262** and the retrieving mandrel **266** are connected to each other in a fluid tight manner by the seals **234** at either end of the actuator screw **262**. This prevents any fluid exchange between the fluid flow port **224** and the chambers **165**A, **165**B, **167**A and **167**B.

The elongated fluid chamber **212** is in fluid communication with the fluid flow port **224** such that fluid entering the coiled tubing can exit through the distal end of the retrieving mandrel **266**. In particular, the distal end of the bypass sleeve **218** is attached to the proximal end of the guide sleeve **138** through a threaded connection and the connection is sealed with the seals **116**. Interconnection ports **244** are defined between where the elongated fluid chamber **212** ends adjacent to the end of the bypass sleeve **218** and where the fluid flow port **224** begins at the proximal end of the drive mandrel **250**. These interconnection ports extend through the guide sleeve **138** and the drive mandrel **250** generally perpendicular to the direction of the elongated fluid chamber **212** and the fluid flow port **224**. Fluids pumped through the coiled tubing will flow through the space (i.e. chamber **212**) between the bypass sleeve **218** and the outside diameter of the tool (i.e. electronics housing **114**) then it will cross over to the inside of the tool through the ports **244** in the guide sleeve **138** and the drive mandrel **250** to the fluid flow port **224**. Although the coiled tubing connector **206** and the bypass sleeve **218** are depicted as separate from the electronics housing **114**, it will be appreciated that they may be interconnected such that flow passages, rather than a complete chamber **212**, may be defined.

The flow path through the tool may be used for other purposes. For example, fluids may be pumped through to perform clean-outs for fishing jobs or for formation stimulation. Another option is to pump fluids, particularly cold fluids, around the electronics. If the tool is being run into a hot well whose temperature exceeds the temperature rating of the tool, by pumping cold fluids through the tool, the electronics section will be cooled thereby enabling the tool to perform.

FIGS. **2**A to **4**C and **6**A to **6**C depict the slips **180** as the means of fixing the tool **110** in place. Other means may also be used. FIG. **7** provides an example of a portion of a retrieving tool **300**. The tool **300** is shown within three segments of tubing or casing **388**, **386** and **384**. The middle segment of tubing or casing **386** is a landing nipple which has a profile **390** defined around the interior surface.

The tool **300** comprises a bottom housing **364** comparable to bottom housing **164** previously described. The bottom housing **364** is connected to a retrieving housing **374** which in turn connects to a locking lug holder **326**. Locking lugs **350** are movably held within the locking lug holder **326**. The outer contour of the locking lugs **350** matches the profile **390** so that the locking lugs **350** fit into the profile **390**.

A retrieving mandrel **366** extends axially through the centre of the bottom housing **364**, the retrieving housing **374**, the locking lug holder **326**, and the locking lugs **350**. The retrieving mandrel **366** has an essentially constant circular diameter. However, the retrieving mandrel **366** has two necked down portions **327** and **328** which are used to position and release the locking lugs. Springs or other biasing means **352** are positioned between the retrieving mandrel **366** and the locking lugs **350**. The locking lugs **350** are movable inwards and outwards perpendicular to the direction of travel of the retrieving mandrel **366**. The springs **352** bias or push the locking lugs **350** in the outwards direction.

In use, the springs **352** are initially positioned in the necked down portion **327** of the retrieving mandrel **366**. The tool **300** is inserted into the well with the mandrel **366** held in this position until the locking lugs **350** reach the profile **390** of the landing nipple **386**. The locking lugs **350** are forced outward and locked in position in the profile **390** as shown in FIG. **7**A. Actuation of the tool **300** will cause the retrieving mandrel **366** to move upward (to the left in the FIGS. **7**A to **7**C) relative to the locking lugs **350** and the housings **364** and **374** to perform its retrieving function. A larger diameter portion of the mandrel **366**, as shown in FIG. **7**B will come between the locking lugs **350** and further compress the spring **352**. The larger diameter portion of the mandrel **366** will lock the locking lugs **350** in place. As the retrieving function is performed, the retrieving mandrel **366** is moved upwards relative to the locking lugs **350** until the second necked down portion **328** of the mandrel is positioned under the lugs **350** and the springs **352**. The locking lugs **350** can now be forced inward in the second necked down portion **328** of the retrieving mandrel **366** so that the locking lugs **350** are drawn out of the landing nipple **386** and the tool **300** can be withdrawn from the well. Other locking means may also be used.

In addition to the setting and retrieving applications already described, the tools described herein can also be used for other applications such as shifting of sleeves and measuring the location of an object in the well. For example, if the tool is locked in a known position in the well, the mandrel can be extended and the positioning encoder **122** or other counter can be used to precisely determine the location of the end of the tool and therefore the location of an object contacted by the tool.

Extended reach slip assemblies can be used to perform retrieving, shifting or measuring operations in through tubing applications.

The number of housings and configurations depicted in FIGS. **2**A to **7**C is based, at least in part, on manufacturing concerns. The invention encompasses tools having more or fewer housings. The tubular shape of the housings is preferred but not essential.

Although seals are depicted throughout the figures, seals may be unnecessary between the relatively stationary parts if a sufficiently tight fit is present.

The mechanical means of interconnecting the various components of the tool shown in the figures are exemplary only. Other known mechanical means of interconnecting the various components are contemplated by the invention.

Numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

The invention claimed is:

**1**. A well tool for applying a pulling or a pushing force to an object in an interior of a well bore comprising:

a) a drive mandrel;

b) an engaging mandrel;

c) an actuator;

d) a housing sealing a portion of the drive mandrel and a portion of the engaging mandrel within an interior space, the drive mandrel and the engaging mandrel extending from opposite ends of the housing;

e) a drive mandrel piston area defined at a drive mandrel end portion of the housing between an outside diameter of the housing and an outside diameter of the drive mandrel sealed at the housing;

f) an engaging mandrel piston area defined at an engaging mandrel end portion of the housing between the outside diameter of the housing and an outside diameter of the engaging mandrel sealed at the housing;

g) a motor housing coupled to the housing wherein cooperating protrusions and longitudinal slots are defined on the housing and on the motor housing;

wherein the actuator is adapted to reversibly move the housing longitudinally relative to the drive mandrel and the engaging mandrel, with the protrusions sliding within the slots during the relative movement, and

wherein the drive mandrel piston area and the engaging mandrel piston area are substantially equal so that external pressure acting on the two piston areas, generates two opposing forces that are substantially balanced during relative movement.

**2**. A well tool for applying a pulling or a pushing force to an object in an interior of a well bore comprising:

a) a drive mandrel;

b) an engaging mandrel;

c) an actuator;

d) a housing sealing a portion of the drive mandrel and a portion of the engaging mandrel within an interior space, the drive mandrel and the engaging mandrel extending from opposite ends of the housing;

e) a drive mandrel piston area defined at a drive mandrel end portion of the housing between an outside diameter of the housing and an outside diameter of the drive mandrel sealed at the housing;

f) an engaging mandrel piston area defined at an engaging mandrel end portion of the housing between the outside diameter of the housing and an outside diameter of the engaging mandrel sealed at the housing; and

g) a fluid conduit defined longitudinally through the tool and extending through the drive mandrel and the engaging mandrel;

wherein the actuator is adapted to reversibly move the housing longitudinally relative to the drive mandrel and the engaging mandrel, and wherein the drive mandrel piston area and the engaging mandrel piston area are substantially equal so that external pressure acting on the two piston areas, generates two opposing forces that are substantially balanced during relative movement.

**3**. The well tool according to claim **2** further comprising a sealed electronics housing internal to the fluid conduit.

**4**. A well tool for applying a pulling or a pushing force to an object in an interior of a well bore, comprising:

a) an inner elongated member;

b) an outer elongated member encircling an intermediate segment of and longitudinally moveably engaged with the inner elongated member wherein the inner elongated member is extendable from both ends of the outer elongated member;

c) a screw component of the inner elongated member, the screw component being coupled for rotation about a longitudinal axis; and

d) a threaded component of the outer elongated member engaged with the screw component;

wherein rotation of the screw component reversibly moves the outer elongated member relative to the inner elongated member.

**5**. The well tool according to claim **4** wherein the inner elongated member includes a drive mandrel rotatably coupling the screw component to a motor.

**6**. The well tool according to claim **5** wherein the inner elongated member includes an engaging mandrel at its distal end coupled to a distal end of the screw component.

**7**. The well tool according to claim **6** further comprising a fluid conduit defined longitudinally through the tool wherein the fluid conduit extends through the drive mandrel and the engaging mandrel.

**8**. The well tool according to claim **4** further comprising an anchor for selectively anchoring a distal end of the outer elongated member to an interior wall of a well bore.

**9**. The well tool according to claim **4** wherein cooperating protrusions and longitudinal slots are defined in the inner elongated member and the outer elongated member and the protrusions slide within the slots when the inner elongated member moves relative to the outer elongated member.

**10**. A well tool for applying a pulling or a pushing force to an object in an interior of a well bore, comprising:

a) an inner elongated member;

b) an outer elongated member encircling an intermediate segment of and longitudinally moveably engaged with the inner elongated member wherein the inner elongated member is extendable from both ends of the outer elongated member;

c) a screw component of the inner elongated member, the screw component being coupled for rotation about a longitudinal axis;

d) a threaded component of the outer elongated member engaged with the screw component; and

e) a thrust bearing;

wherein rotation of the screw component reversibly moves the outer elongated member relative to the inner elongated member;

wherein the inner elongated member includes a drive mandrel rotatably coupling the screw component to a motor;

wherein the inner elongated member includes an engaging mandrel at its distal end coupled to a distal end of the screw component; and

wherein the thrust bearing couples the engaging mandrel to the screw component wherein only longitudinal movement of the screw component is transmitted to the engaging mandrel.

**11**. A well tool for applying a pulling or a pushing force to an object in an interior of a well bore, comprising:

a) an inner elongated member;

b) an outer elongated member encircling an intermediate segment of and longitudinally moveably engaged with the inner elongated member wherein the inner elongated member is extendable from both ends of the outer elongated member;

c) a screw component of the inner elongated member, the screw component being coupled for rotation about a longitudinal axis;

d) a threaded component of the outer elongated member engaged with the screw component;

e) a fluid conduit defined longitudinally through the tool; and

f) a sealed electronics housing internal to the fluid conduit;

wherein rotation of the screw component reversibly moves the outer elongated member relative to the inner elongated member;

wherein the inner elongated member includes a drive mandrel rotatably coupling the screw component to a motor;

wherein the inner elongated member includes an engaging mandrel at its distal end coupled to a distal end of the screw component;

wherein the fluid conduit extends through the drive mandrel and the engaging mandrel.

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